IWR
INSTITUTE FOR WATER RESOURCES

Thoughts on Data/Analytical Programs - Application to an Overview of the NETS Program

Bruce Lambert
Institute of Water Resources

US Army
Corps of Engineers

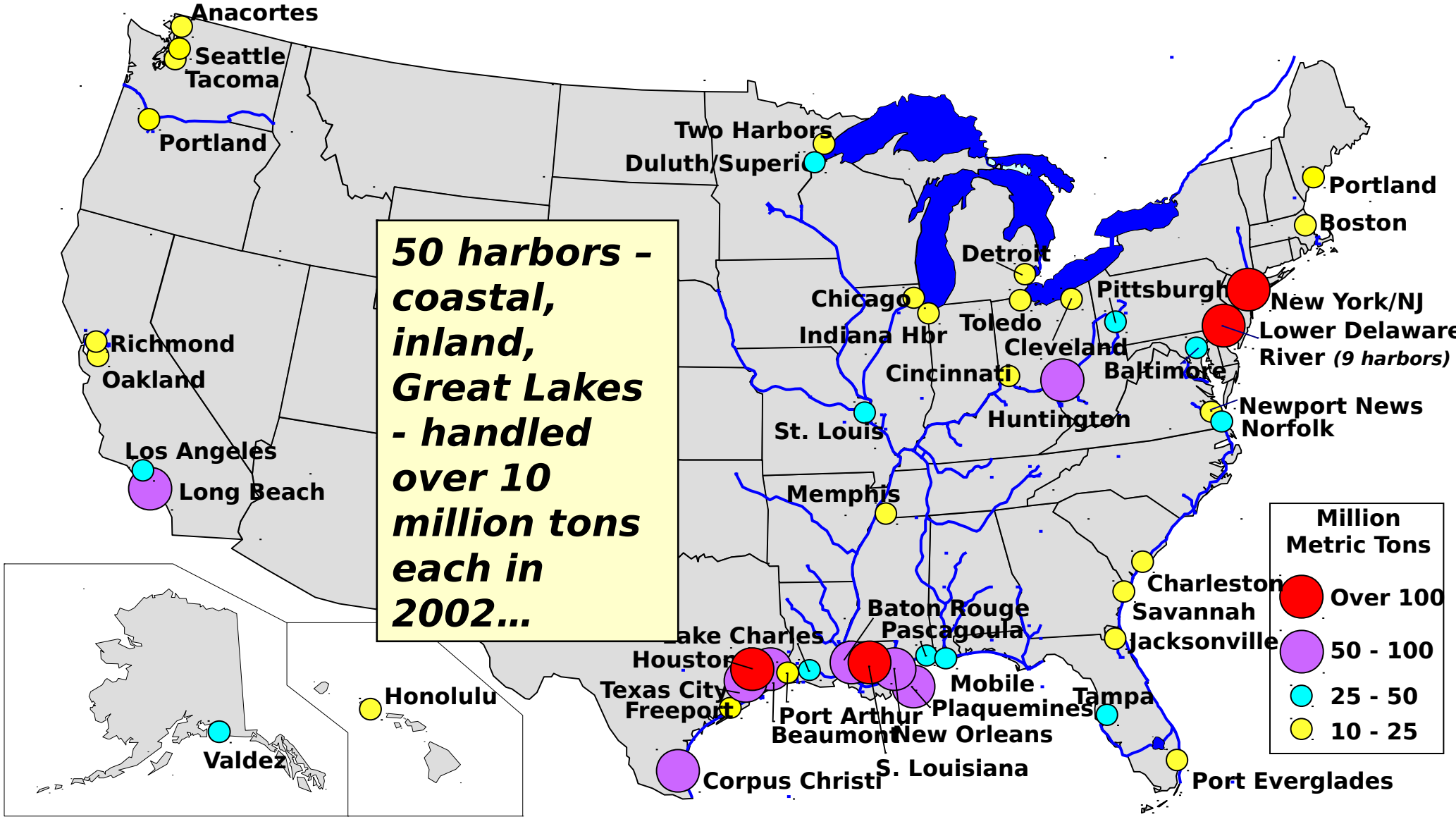
Why do we even have Federal Data/Analytical programs?

- What are potential markets,
- What infrastructure is needed,
- What are implications from policy decisions,
- What are the emerging trends,
- What resources are necessary,
- Are we collecting all revenues due,
- What is my competition thinking
- To satisfy congressional mandat
- The simple need to know.

How Can One Look At the Navigation Industry?

- Inventory Functions – physical characteristics, numbers of facilities, labor, equipment, infrastructure
- Engineering – structural integrity, deterioration
- Operational Reliability – delay, closures
- Economical and Financial – Cost/Benefit Analysis, capital and financial resources, jobs and taxes
- Safety and Security – number of accidents, exposure
- Markets – hinterlands, multimodal services
- *Non Navigational Users* – Recreation, flood control, hydropower, Fish and Wildlife, water supply

U.S. Ports: Vital to Trade ...and to Our National Economy



Maritime Infrastructure Conditions and Concerns

- 25,000 miles of waterway and harbor channels handle 2.4 billion tons of cargo vital to economy
- Half of locks exceed 50-year design life and lock maintenance downtime has doubled
- Maintenance backlog will increase to nearly $700 million under FY 2005 Budget
- Harbor improvements are needed to handle new larger vessels to remain competitive in world trade
- Lock Construction Projects underway to meet these needs have been delayed by 5-10 years due to funding shortfall
- Billions of dollars in economic benefits of projects foregone due to delays in construction of harbor and waterways

We all support programs that:

- Verify the nature of traffic flows across our respective countries, borders, and terminals
- Understand linkages to supply chains, commodities and routing
- Generate information for policy and planning studies
- Provide output to other users (state, local, and industry partners)

The understanding of data/analytical needs – "No One Loves Us"

Does the problem lie with the data providers?

- Data providers do not know the users
- Tend to skew work based on the a few power users
- Not engaged in promotion
- Seek statistical purity – difficult to mix datasets
- Program based
- Wrong Price points?
- Want to be defensible, replicable and reviewable

How many legs does a dog have if you call the tail a leg? Four; calling a tail a leg doesn't make it a leg. Abraham Lincoln

Does the problem lie with users?

- The users do not promote the data, guard secrets as competitively valuable
- Tend to highlight their use (transformation) of data
- Not as concerned with statistical rigor
- Tasked based
- Wrong Price points?
- Assume data is always available
- Not necessarily concerned with public review or replication

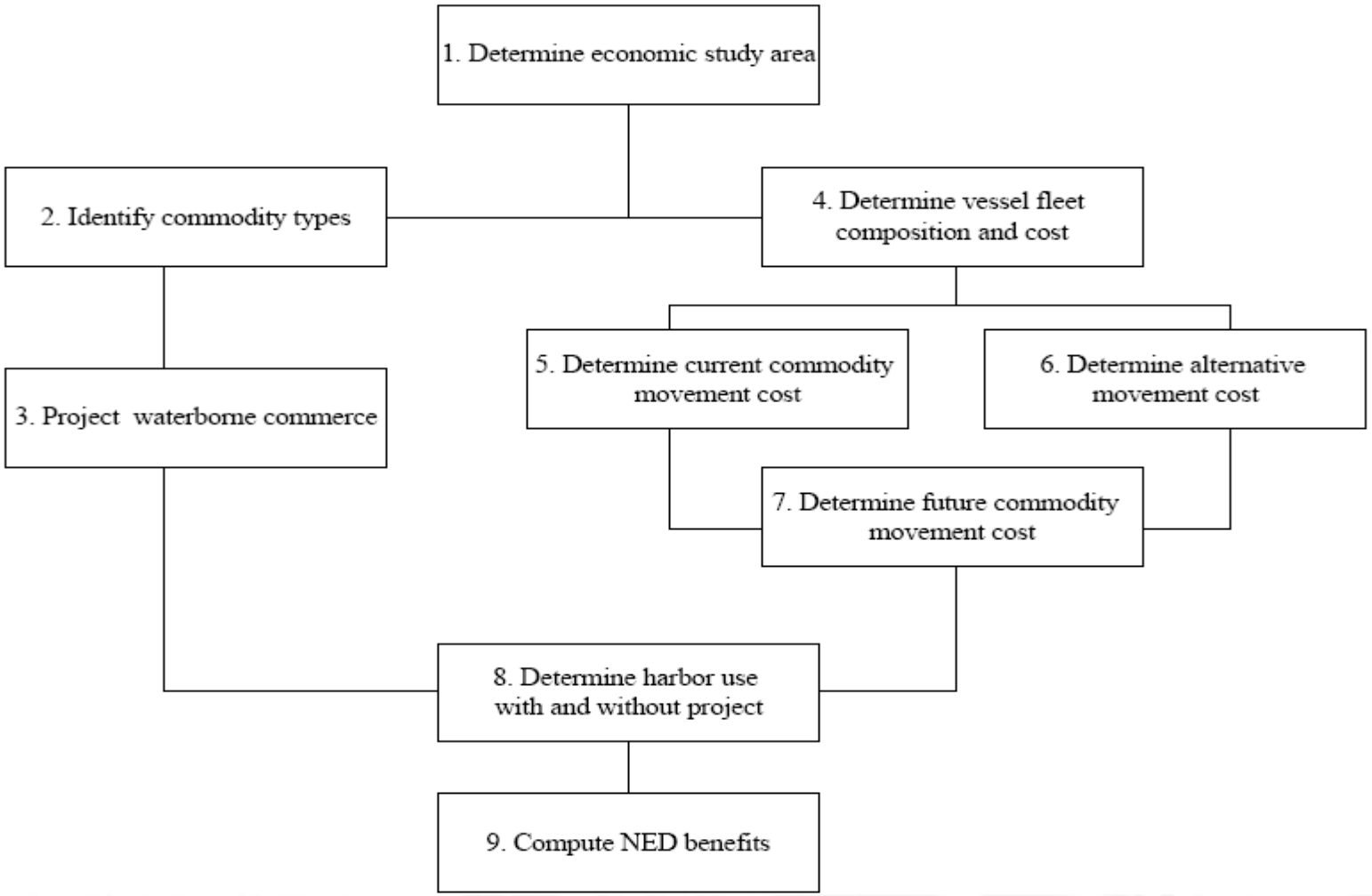
If the facts don't fit the theory, change the facts. Albert Einstein

These Efforts Raise Many Questions

- What are the correct tools and information?
- Will these tools raise the awareness to program projects that are beneficial to freight? Do they help people make informed decisions?
- What tools and data elements are still needed?
- Can tools be developed to balance the wide range of border crossing needs?
- What is needed to provide additional and timely understanding of markets and trends?
- Are we providing accurate information to satisfy or anticipate future policy, program, legislative requirements?

How do we move from data into analysis while providing useful information?

Figure 2.7.4 - Flow Chart of Deep Draft - Navigation Benefit Evaluation


1. Determine economic study area
2. Identify commodity types
4. Determine vessel fleet composition and cost
3. Project waterborne commerce
5. Determine current commodity movement cost
6. Determine alternative movement cost
7. Determine future commodity movement cost
8. Determine harbor use with and without project
9. Compute NED benefits

Source: Principles and Guidelines

NETS Program

- The goal of NETS is to advance the Corps' engineering with state-of-the art tools and techniques for economic modeling and analysis.
- Team includes:
  - Academics from seven universities
  - Representatives from ORNL, TVA, US Naval Academy, Corps Centers of Expertise for Inland and Deep Draft,
- Attempt to develop models to improve planning and project studies for field research
  - Models are to be transparent and portable
  - Free to use and access
- Work continues to FY 08

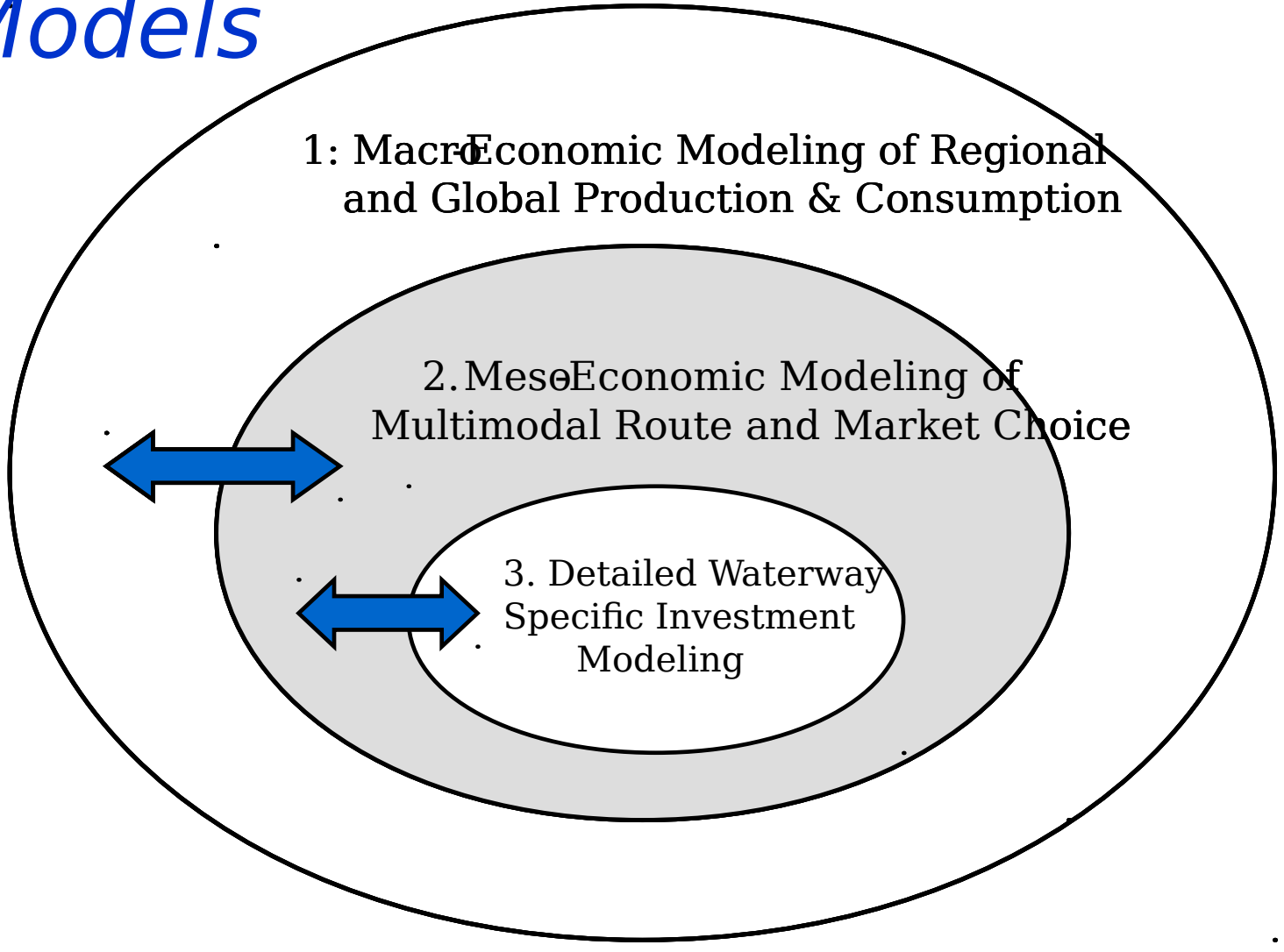
Estimating Shipper Response

- A series of surveys are being conducted to estimate response to changes in waterway attributes. These include congestion, reliability, rates and travel time.

- Two studies have been competed:
  - Modeling Preferences for Upper Mississippi Grain Movements: The Mid-American Grain Study
  - Transportation Demand in the Columbia-Snake River Basin

- Additional studies will be competed on the Ohio and the Upper Mississippi Rivers this year.

Relationship between NETS Models


1: Macro-Economic Modeling of Regional and Global Production & Consumption
2. Meso-Economic Modeling of Multimodal Route and Market Choice
3. Detailed Waterway Specific Investment Modeling

= feedback between levels

= level of modeling discus
this presentation

Macro Level Model -Container Flow Project Goals

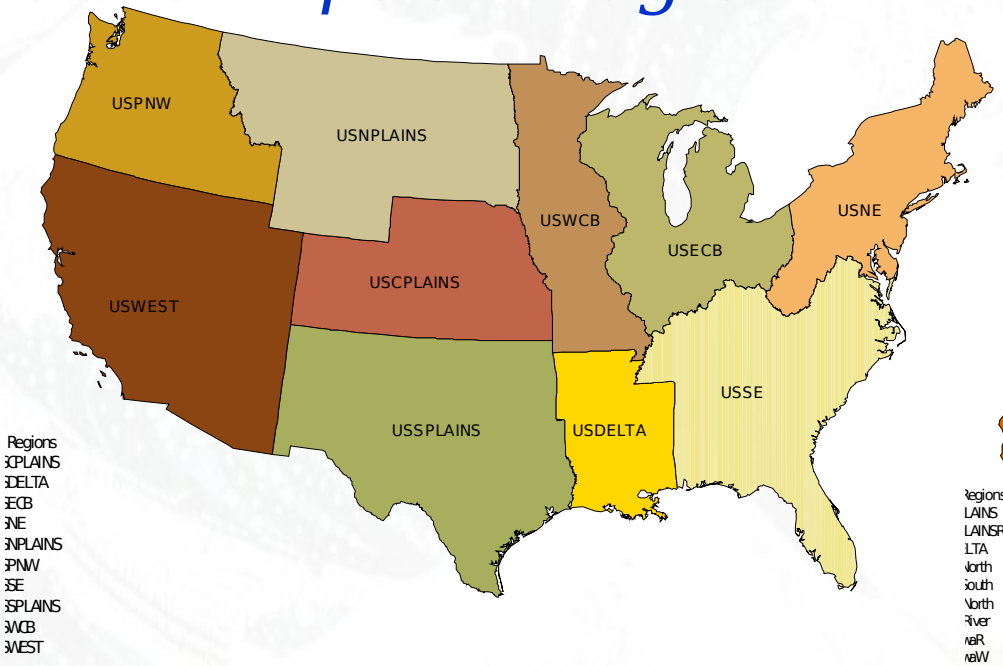
- Review previous studies on container shipping with a focus on infrastructure and projections;
- Describe historical movements in world trade;
- Describe and analyze historical movements in US markets as well as the rail market and ocean shipping economies;
- Review and critique alternative models that can be used to analyze flows, restrictions, expansion possibilities and make projections.

Macro Level Model -World Grain Model

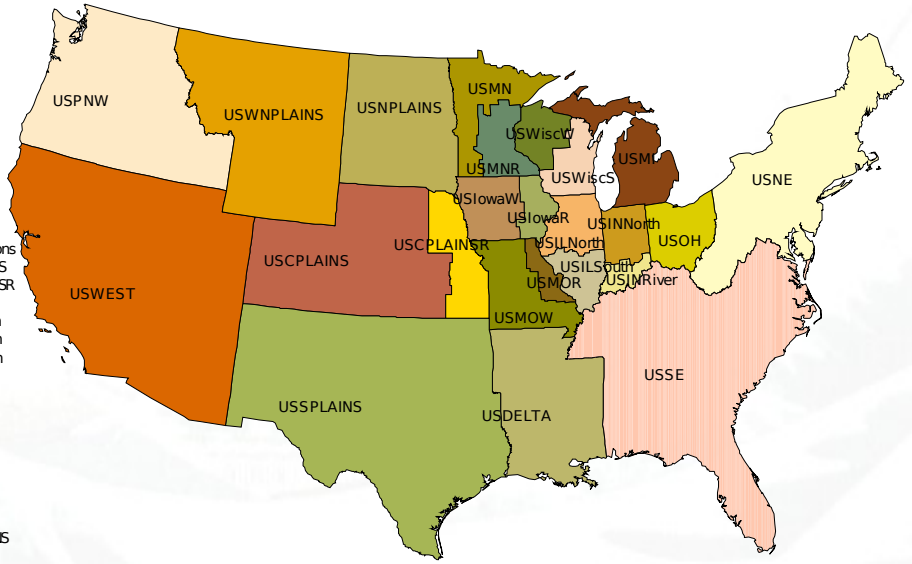
- Develop a spatial equilibrium model to forecast international commodity flows from a specific region.
- Focus will be on the world grain trade and expected market responses to evolving competitive pressures and structural changes.
- Methodology will be generally applicable to a broad range of commodities or regions

Grain Regions within US

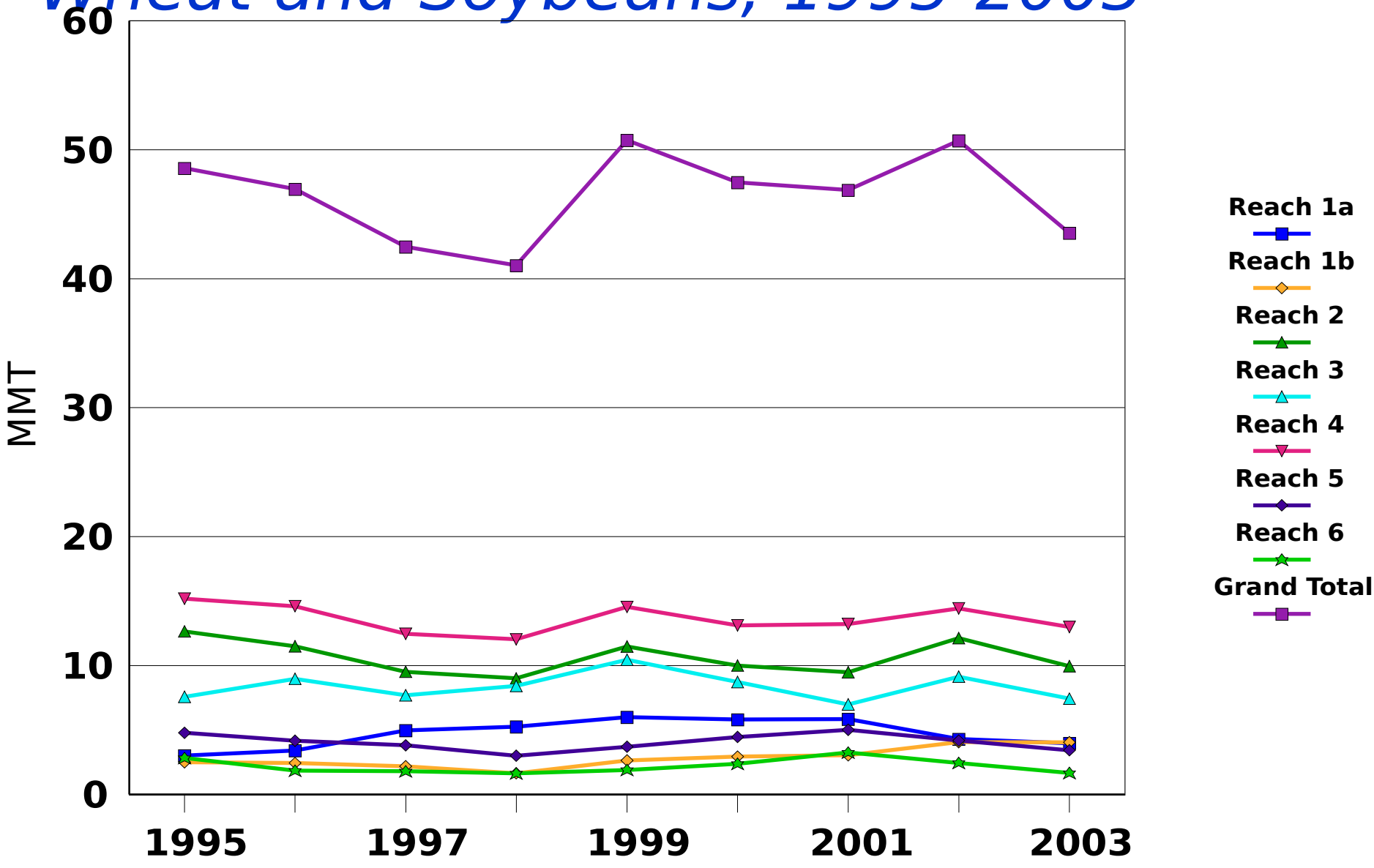
Consumption Regions



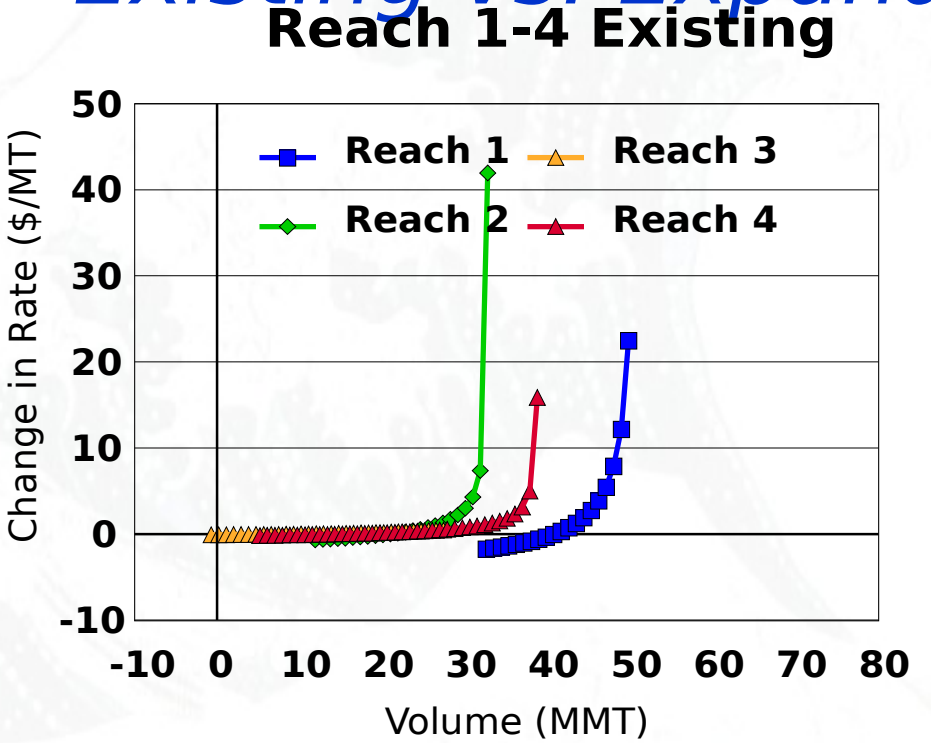
Production Regions

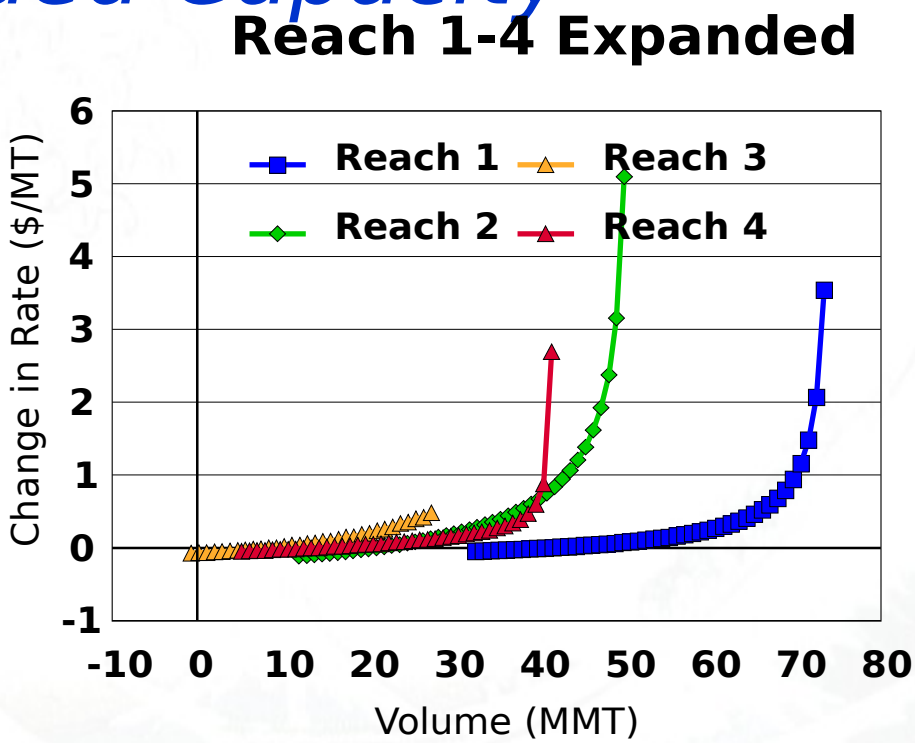


Barge Loadings by Reach, Corn, Wheat and Soybeans, 1995-2003



Relationship Between Change in Barge Rate and Volume by Reach and Existing vs. Expanded Capacity





Meso Level Model - Regional Routing Model Objectives

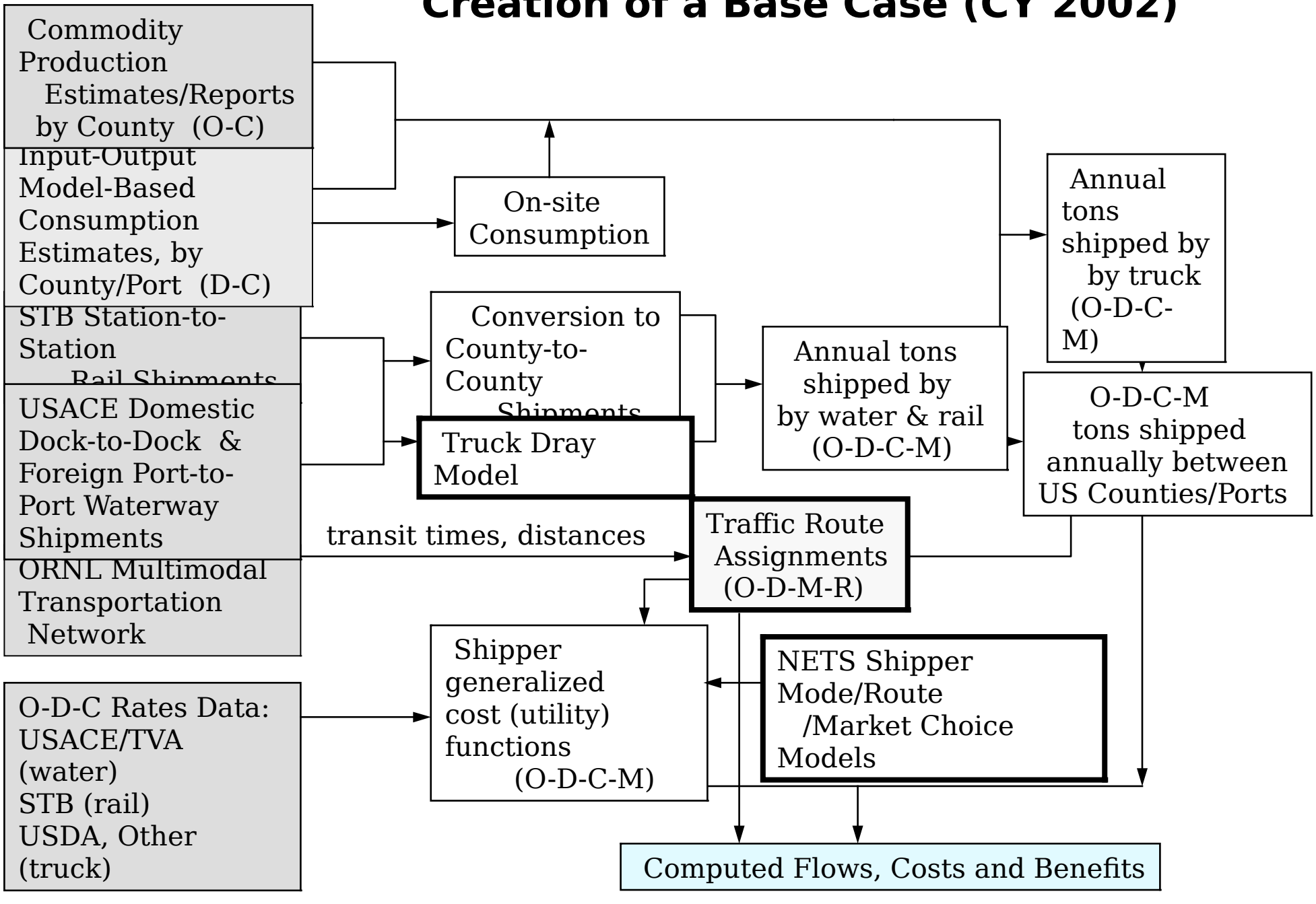
- Construct Database of Origins, Destinations, Modes, Rates and Commodities for base year
- Utilize infrastructure networks to assign the traffic and system capacity
- Estimate the effects of changes in demand and network-based supply on these flows and their costs
- Provide User Interface to RRM data and analysis
- Understand relationships of other data/models

Prototype Database

- Five commodities picked

  Corn, Wheat, Soybeans, Apples, Processed Poultry
- Base Year – 2002 (1997, 2003 partials)
- Geography – County to County flows
- Mode – waterway, rail, truck
- Domestic and International Shipments

Creation of a Base Case (CY 2002)


Commodity Production Estimates/Reports by County (O-C)
Input-Output Model-Based Consumption Estimates, by County/Port (D-C)
STB Station-to-Station Rail Shipments
USACE Domestic Dock-to-Dock & Foreign Port-to-Port Waterway Shipments
ORNL Multimodal Transportation Network
O-D-C Rates Data: USACE/TVA (water) STB (rail) USDA, Other (truck)
On-site Consumption
Conversion to County-to-County Shipments
Truck Dray Model
transit times, distances
Annual tons shipped by by truck (O-D-C-M)
Annual tons shipped by by water & rail (O-D-C-M)
O-D-C-M tons shipped annually between US Counties/Ports
Traffic Route Assignments (O-D-M-R)
Shipper generalized cost (utility) functions (O-D-C-M)
NETS Shipper Mode/Route /Market Choice Models
Computed Flows, Costs and Benefits

USDA – MOU and Data

- Provided I/O Matrix of five commodities for 2002 for production and consumption (can do other commodities as needed)
- Imports and exports are explicitly recognized in I/O Model
- Have a completed unsuppressed Ag. Census
- Will serve as final reviewer for prototype GIS development

TVA Data and Rate information

Provided 1997, 2002 and 2003 dock-to-dock datasets for:

- U.S. Produced Grains (Corn, Wheat, Soybeans):

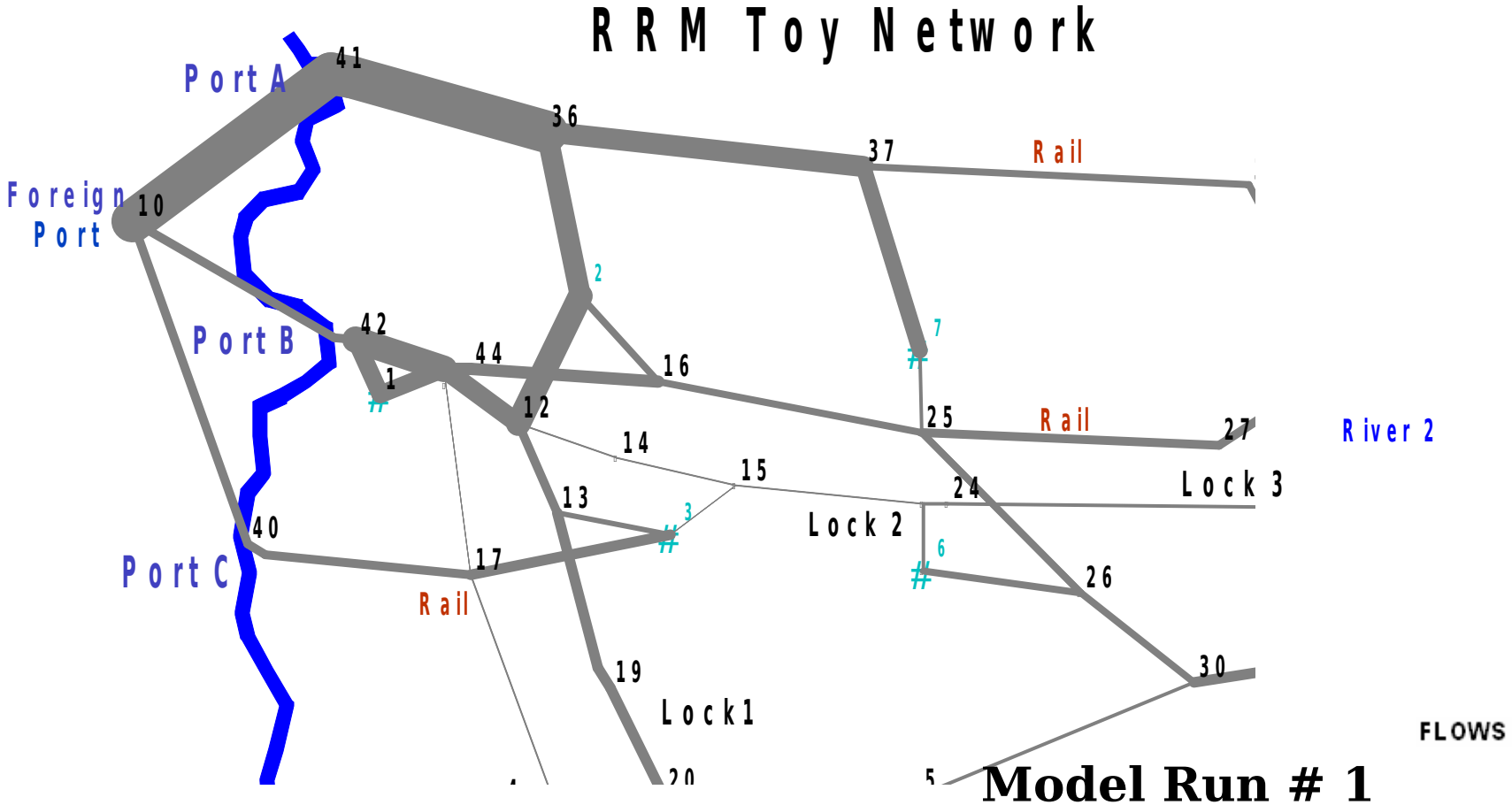
  Annual and quarterly dock-to-dock movement tonnages and average shipment rates, for most regions

- All Commodities:

  Annual and quarterly dock-to-dock movement tonnages, by commodity class, all locations

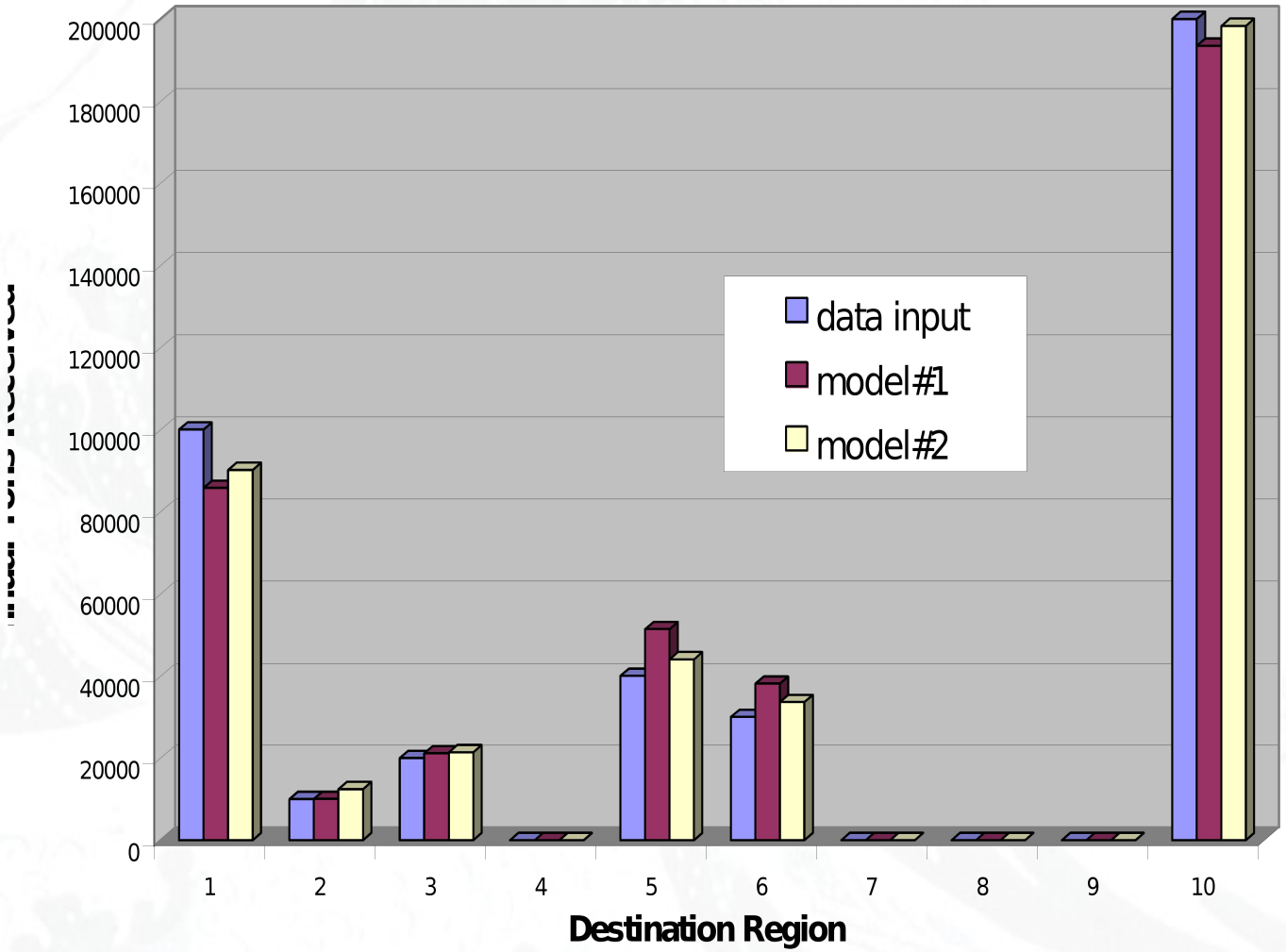
* Rates for Columbia-Snake-Willamette Rivers currently missing

Prototype Model #1 – Constrained Waterway locks



Origin Mode Split = 36.7% water
63.3 % rail

Destination Flow Comparisons for Base and Two Model Runs



If routes shift, idea is that you would see a mode shift or destination shift.

Does the model data vary from observed? Does data move in right direction?

Microscopic Systems Models

Evaluation of:

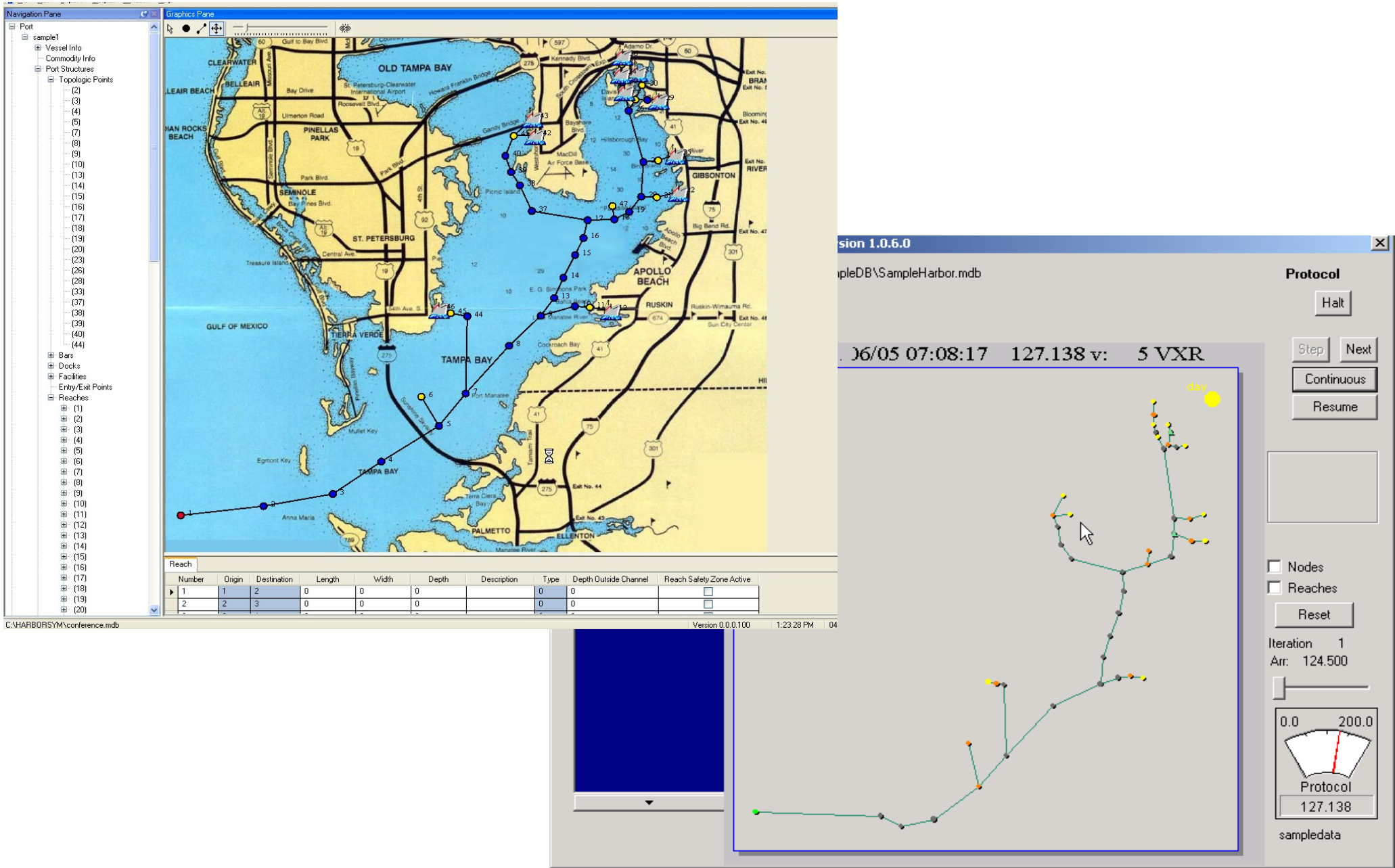
- Tradable locking permits
- Scheduling – Appointment system
- Congestion pricing
- Lockage efficiency measures
- Locking policies
- Structural changes that increase capacity.

Microscopic Systems Model - Navigation System Simulation Model (NaSS)

- Design and build a discrete-event multi-lock simulation model that:
  - Generates and moves vessels through a network of waterways and locks
  - Incorporation of scheduled and unscheduled outages and associated shipper response.

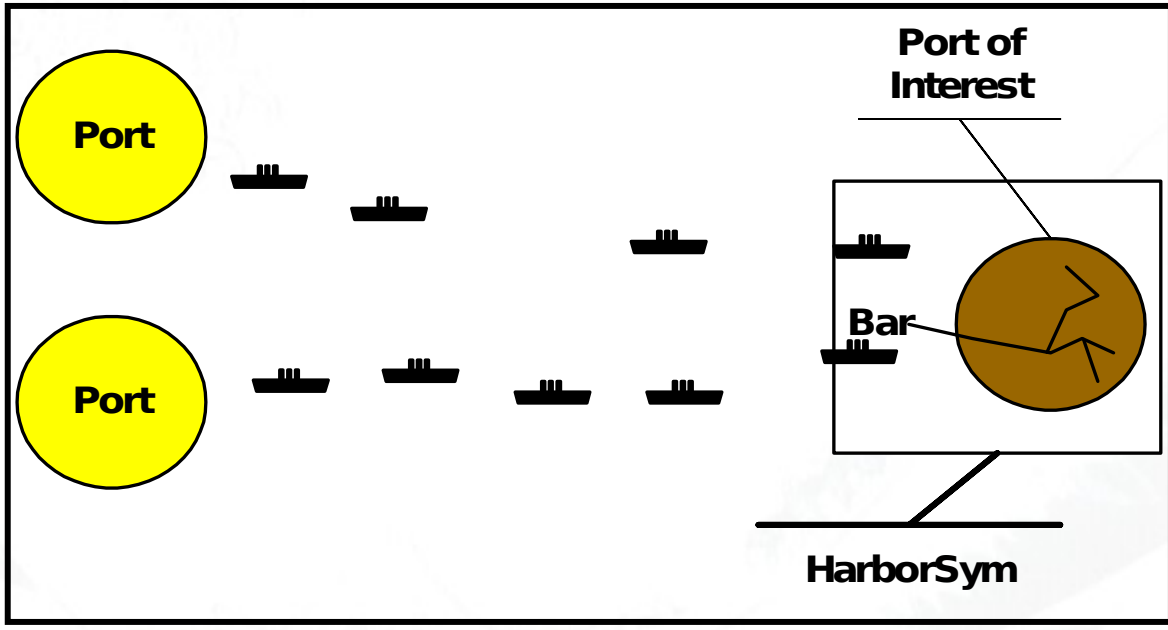
- Design Document is currently being updated to respond to independent peer review.

Can you turn a port into a Model?



HarborSym Model

- Planning-Level Model
- Data Input
  - Port layout
  - Vessel Calls
  - Speeds
  - Transit Rules
- Model Calculation
  - Vessel interactions within harbor
- Assumptions
- Output
  - Times in system (travel, docking, etc.)
  - Delay times



Vessel Call Data Base

- Unique Vessels
  - Vessel class
  - Physical characteristics
- Vessel Call
  - Arrival Time / Draft
- Dock Visits
- Commodity Transfers
  - Quantity / Commodity Category
  - Import/Export
- Microsoft Access Relational Database

Vessel Movement on Network

- Vessel moves on pre-determined (model calculated) route through reaches
- Leg – 3 types
  - Bar to Dock / Dock to Dock / Dock to Bar
- Transit Rules tested for Leg
  - Check rules / conflicts with other vessels
  - Vessels already in leg have priority
  - Wait until can proceed
  - Can move to intermediate anchorage/holding area
- Can wait at Bar, Dock, Holding Area if rule violation in Leg

Commodity-Driven Forecast Tool

- Assist in developing balanced / rational fleet and commodity forecasts
- Inputs
  - Commodity / Fleet / Constraints
- Methodology
  - Translate Annual Commodity Forecast to Vessel Calls
  - Use up fleet resource subject to constraints (Dock Draft Limitations, commodities, docks)
- Outputs for synthetic vessel calls for HarborSym
  - Forecast Satisfaction / Detailed Calls
  - By Dock, Commodity, Import/Export
  - Fleet Specification by class
    - Potential Calls / Priority
    - Statistical Description of Physical Characteristics
  - Loading Factor Distribution By Class/Commodity

Methodology – Vessel assignment

- Generate set of distinct vessels based on fleet specification
- Loop through commodity demands
  - Find a vessel that can carry the commodity at the dock (subject to constraints)
  - Load it to maximum, subject to loading factor and depth limitation at dock
  - Reduce commodity demand at dock by amount loaded
  - Remove vessel from available set
  - Next demand
- Stop when:
  - no more suitable vessels available
  - or all forecasts satisfied
- Assign trip times
- Report results / store in database

Forecast Tool Outputs - Forecast Satisfaction / Vesse Movements

Commodity	Dock	I/E	Quantity	Allocated	Deficit	% Deficit	# Calls
Crude	11 Exxon Mobil	I	2624988 1	7397000	1885288 1	71.82 %	122
Crude	7 Fina Oil	I	2014628 7	7344750	1280153 6	63.54 %	122
Crude	3 Chevron Motiv	I	9072806 2	6332825	2739980	30.20 %	109
Petroleum Products	5 Lone Star	I	69403	69403	0.00	0.00%	2
Petroleum Products	4 Premcor	E	204896	204896	0.00	0.00%	6

Arrival	DockCode	Commodity	Import Quantity	Export Quantity	Entry Draft	Name
1/4/2001 5:33:31 AM	6 DuPont	Crude	66703	0	69.3	OT2000
1/4/2001 1:07:14 PM	8 Union Oil	Crude	90526	0	69.6	OT4006
1/4/2001 6:09:29 PM	3 Chevron Motiv	Crude	38674	0	61.6	OT1000
2/28/2001 11:28:26 AM	8 Union Oil	Petroleum Products	0	28933	18	CT1019
3/5/2001 11:22:00 AM	11 Exxon Mobil	Petroleum Products	0	18162	20	BC1009
3/6/2001 5:37:56 AM	3 Chevron Motiv	Petroleum Products	0	45271	23	GC2009

Nets and Data

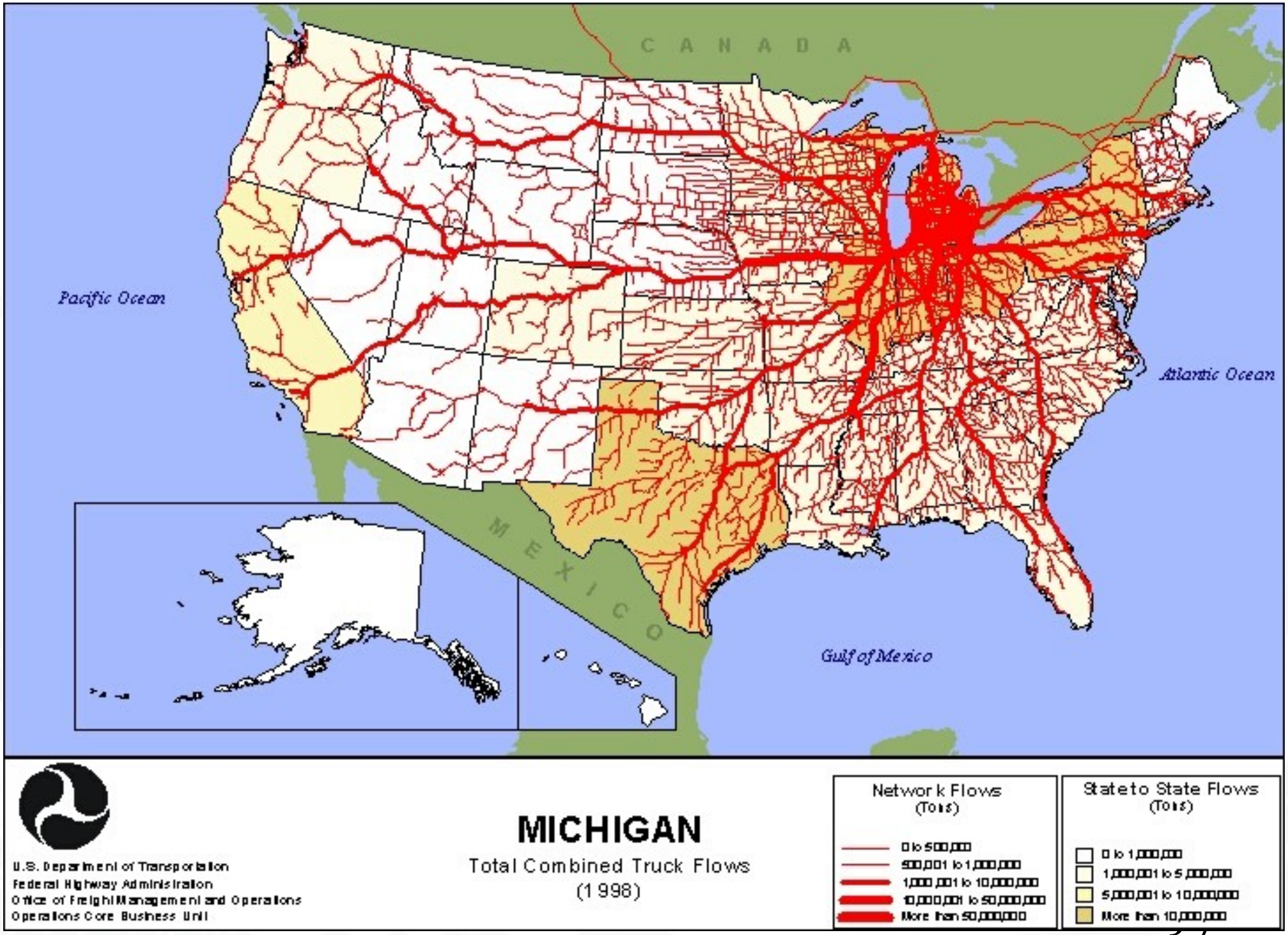
- Reliant upon primary datasets from many sources
- Many data fusion efforts
- New survey approaches linked to economic models

- Long term viability depends upon strength of underpinning databases, many of which are outside of the Corps traditional data programs

We want data, tools and guidance to make better decisions.

- Infrastructure location and capacity of terminals, channels, locks and dams, ports, etc.
- Vessel fleet type and use
- Origins and Destinations to examine corridors and economic relationships
- System performance – Time, Congestion, Delay
- Security and Inspection Activities

No ideal database or framework exists …


CANADA
Pacific Ocean
Atlantic Ocean
MEXICO
Gulf of Mexico
MICHIGAN
Total Combined Truck Flows
(1998)
U.S. Department of Transportation
Federal Highway Administration
Office of Freight Management and Operations
Operations Core Business Unit
Network Flows
(Tons)
0 to 500,000
500,001 to 1,000,000
1,000,001 to 10,000,000
10,000,001 to 50,000,000
More than 50,000,000
State to State Flows
(Tons)
0 to 1,000,000
1,000,001 to 5,000,000
5,000,001 to 10,000,000
More than 10,000,000

Fundamental Questions

- What planning/policy needs remain unanswered or should be answered on a routine basis?
- What data (tools) answers the ongoing policy/planning functions? What data (tools) gaps exist?
- Does the technical expertise to develop and utilize new datasets and analytical tools exist at the appropriate levels?
- Can the Corps use existing partnerships or develop new arrangements to improve both data and analytical capacity?
- Do we wish to share data/tools with others outside of the USACE?
- Are we prepared for the ramifications regarding development/release of these tools?
- Can we develop expertise at all levels?
- *Can we tell the story that Navigation is important? Can we make others confident in telling the same story?*

Communications

- NETS web site launched in January 2005.
- NETS NEWS!
- Presentation to interested groups
- Training available for various models
- Peer review session – September for RRM

Finding "Ultimate Truth" depends on funds, time, motivation, goals, part

For More Information

NETS **http://www.corpsnets.us/**

Keith Hofseth
Senior Economist
NETS Technical Director
Keith.D.Hofseth@iwr01.usace.army.mil
703-428-6468

Bruce Lambert
Senior Economist
Secretary, U.S. Section of PIANC
Bruce.Lambert@usace.army.mil
703-428-6667